3·98 : its hardness (6·5) is between that of quartz and felspar. It has a perfect cleavage, with a splendent metallic lustre, and an imperfect cleavage nearly at right angles to the former. The pebbles themselves show no remains of crystal-faces, are bluish-black in colour, and opaque ; but thin cleavage-flakes, when seen in the microscope, have a peculiar purplish red tint, and in convergent polarized light show a uniaxal figure, of which the axis is just outside the field of vision. When digested with hot strong hydrochloric acid the finely powdered mineral is slowly decomposed, and the titanic acid separates out. In strong hydrofluoric acid complete solution takes place in a few hours. The mineral is infusible with the blowpipe : fused with microcosmic salt it gives the characteristic reaction of titanic acid, notwithstanding the presence of a small proportion of oxide of iron.

Shortly after Mr. Dick's paper had been read, Mr. Baddeley courteously offered to allow me to select a single pebble for the British Museum Collection out of his small store of the mineral, the remaining ones being required by him for sending as samples to be used by searchers in Ceylon. But this store, small though it was, consisted of more than one kind of pebble, the close similarity of aspect being due to friction against a bit of graphite which was with them. On this heterogeneity being pointed out, Mr. Baddeley allowed me to take not only the promised pebble of Geikielite, but also those three pebbles which, not being Geikielite, were useless as samples of that mineral. One of the three fragments proved to be garnet, a second was ilmenite—both of them common minerals—but the third, a fragment of a crystal still retaining some of its faces, presented characters which give it unusual interest.

The fragment, which weighs just over three grams, is black and opaque, and has the general aspect of columbite ; its extremely high specific gravity (6·02) and its hardness (6·5) are also suggestive of that mineral. In microscopic fragments it transmits light and is dichroic, changing from a greenish yellow to brown with the plane of polarization of the light ; the fragments, when examined in convergent polarized light, show a biaxal figure, the apparent axial angle being large (near 70°) ; the character of the double refraction is negative. There is only one well-developed zone of crystal-faces remaining on the fragment ; it consists of two rectangular pairs of parallel faces (pinakoids) and of four prism faces (*m*), the faces of one pinakoid (*a*) being much larger than those of the other (*b*) ; the angle *am*, as determined by means of reflection, is about 44°, but the images of the signal are multiple and wanting in definition ; the dispersion of the optic axes indicates that the system of crystallization is mono-symmetric. Two other faces form a re-entrant edge parallel to the larger pinakoid, and inclined to the edges of the well-developed zone, but whether this is really due to twinning or not is far from evident.

The above set of external characters suggested that the fragment does not belong to any of the known species, and it became necessary to determine its chemical behaviour, but on account of the necessity of preserving the natural faces of what might possibly be an unique fragment, this was a process demanding great caution ; fortunately, the behaviour was such that it was practicable to determine the precise chemical nature of the mineral without interference with the crystal faces, or, indeed, any appreciable destruction of material. It will be sufficient to state here the result, namely, that the material is no other than crystallized zirconia ; the technical details relative to both this mineral and Geikielite will be given in the next number of the *Mineralogical Magazine*. It is remarkable that, notwithstanding the wide prevalence of zircon itself (silicate of zirconium), the natural occurrence of the oxide of zirconium has not previously been noticed. For this new species I beg to suggest the name Baddeleyite, in recognition of the services of Mr. Baddeley to mineralogical science ; but for his close scrutiny of the mineral products of Rakwana, the existence of the above remarkable species would doubtless have long remained unknown.

L. FLETCHER.

NEW BRITISH EARTHWORMS.

THE additions which I have been able to make to our list of indigenous Annelids during the past two years fall naturally into two groups. There are, first, two species which are new to science, and are therefore at present known only as British species. In addition to these there are several species which, while they have been recorded for various Continental stations, have never been found in England till I discovered them among the gleanings which I have passed under review from nearly every part of the country. I shall first of all give a description of the new species.

1. *Lumbricus rubescens*, sp. nov.

This is a genuine Lumbricus in the strictest sense of the word, as it is understood by all those who adopt Eisen's analysis of this group of worms published in 1873. The lip forms a perfect "mortise and tenon," with the first ring or peristomium, and the girdle consists of six segments, four of which bear the *tubercula pubertatis*. I first discovered it in Yorkshire in 1891, and have since then taken it myself at Hornsey in Middlesex, Tunbridge Wells, and Dallington in Sussex, while more recently I have received it from Avonmouth in Gloucestershire.

In general appearance it resembles the common earthworm (*L. terrestris*, L.), as recently defined and differentiated. It is slightly smaller in size, but frequents similar haunts, and might in most respects easily be mistaken for the type. It has the male pores on segment 15 on raised, pale papillæ; but the girdle invariably commences on segment 34, and extends to the 39th, while the band which forms the *tubercula pubertatis* extends over 35 to 38. Its general form and appearance will be best understoood by the study of the woodcut (Fig. 1). Internally it does not differ from the other Lumbrici, but the dorsal pores commence between $\frac{5}{6}$. This makes the fourth true Lumbricus found in the British Isles, and it may be a convenience to collectors if I append a tabular statement of the features by which each is distinguished from the other.

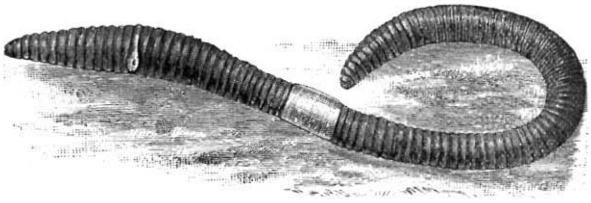

FIG. 1.—*Lumbricus rubescens*, Friend. Natural size.

Chart of the Genus Lumbricus.

Lumbricus	Segments occupied by the					Average length.	No. of segments.
	Girdle.	Tubercula.	First dorsal pore.	Papillæ.	Spermatophores		
Terrestris, Linn...	32—37	33—36	$\frac{8}{9}$	15, 26	? [1]	5 inches	150—200
Rubescens, Friend	34—39	35—38	$\frac{5}{6}$	15, 28	32/33	4 inches	120—150
Rubellus, Hoffm.	27—32	28—31	$\frac{7}{8}$	none	?	3 inches	110—140
Purpureus, Eisen	28—33	29—32	$\frac{6}{7}$	10 (11)	? [1]	2 inches	100—120

It will be seen that there is now a regular series in relation to the first dorsal pore, $\frac{5}{6}$, $\frac{6}{7}$, $\frac{7}{8}$, $\frac{8}{9}$, as well as in the matter of length from 2 to 5 inches and upwards, and number of segments from 100 to 200 or thereabouts. These points are worthy of note in the study of the evolution of worms.

2. *Allolobophora cambrica*, sp. nov.

This species, which I have since found in several parts of England, first came to my notice as a new species from Wales. Hence the specific name. I had previously assigned it to one or other of the related species, but eventually found on dissection that it was quite distinct from every other worm of which I have been able to obtain any description.

At first sight *A. cambrica* has all the appearance of the mucous worm (*A. mucosa*, Eisen). Its average length in spirits is about 2 inches, but when living, and moderately extended, it measures three inches. It is of a fleshy colour, with a somewhat transparent skin, so that the blood-vessels can be well observed between the girdle and the head. The dorsal pores are conspicuous in specimens which have been placed in methylated spirits, the first occurring between segments 4 and 5. The

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[1] Vejdovsky and others mention the occurrence of Spermatophores on these species, but do not state the position. The point is one which should not be ignored.

setæ are in four couples, the individuals of which are near each other. The girdle covers segments 29 to 37, while 31 : 33 : 35 bear each a pair of tubercules (Fig. 2) as in the green worm (*A. chlorotica*). There are two pairs of spermathecæ in segments 10 and 11, opening anteriorly ; the male pore on segment 15 is borne on prominent papillæ, which cause the adjoining segments to appear swollen (Fig. 3). It is a very clean worm, exudes but little mucus as compared with the green worm ; the tail is much longer than in that species, which, in the matter of girdle and tubercules, it most nearly resembles. It will be well to tabulate the points in which this worm resembles and differs from its nearest allies.

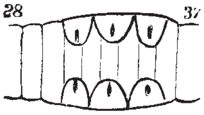

FIG. 2.—Diagram of girdle of *A. cambrica*, Friend, showing tubercula on ventral surface.

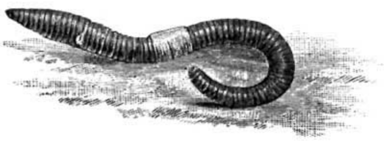

FIG. 3.—*Allolobophora cambrica*, Friend. Natural size.

Allolobophora cambrica resembles

Allo. chlorotica	*Allo. mucosa*
in position and appearance of male pore, girdle, and *tubercula pubertatis*.	in colour, shape, size, activity, position of first dorsal pore, and appearance of male pore.

It differs

in mucus, transparency, length and shape of tail, and number of spermathecæ.	in position and shape of girdle, position of *tubercula pubertatis*, and general outline.

Tabular View.

Allolobophora	Segments occupied by the				General observations.
	Girdle.	Tubercula.	First dorsal pore.	Spermathecæ.	
Chlorotica	29—36	31 : 33 : 35	$\frac{4}{5}$	9 : 10 : 11	Dirty green, opaque, sluggish, and grub-like, exudes much mucus
Mucosa	26—32	29 : 30 : 31	$\frac{4}{5}$	10 : 11	Flesh-coloured, active, with transparent epidermis, little mucus
Cambrica	29—37	31 : 33 : 35	$\frac{4}{5}$	10 : 11	Closely resembling *A. mucosa* in general features

When our knowledge of the hybridity of worms is more perfect, it is possible that some new light will be thrown upon such coincidences as these. I have received the worm from, or collected it in, Nottinghamshire, Hertfordshire, Yorkshire, and Montgomeryshire. I believe I have also found it in Westmorland and elsewhere, but entered it either under one or the other of the two species which it so closely resembles.

Next, we have to note the worms which are new to Britain, though not new to science. These all fall under the genus Allolobophora, and several of them are so well marked that I have, in some recent articles on this subject, revived Eisen's subgeneric term Dendrobæna, and placed under it about half-a-dozen species of tree-worms which are more or less widely distributed in this country.

The tree-worms are small, hardy, and active ; the lip is usually very delicate, and appears to be used, not only as a sucker and boring agent, but also as a tissue dissolver, probably by the use of a special saliva. The setæ are usually in eight almost equidistant rows, and the lip cuts more or less deeply into the first ring. The type of this group is *Dendrobæna Boeckii*, Eisen, which has been the subject of endless confusion. The true species, following the diagnosis of Eisen, is very rare in England, and I have found it nowhere but in Airedale and Wharfdale, Yorkshire. I believe all the other records which have been given by other writers should be assigned to the much more common and widely distributed species known as *Allolobophora subrubicunda*, Eisen. This worm belongs to the same group, but lives among vegetable *débris*, as well as beneath the bark of decaying trees. Another species (*A. arborea*, Eisen) is found only in dead timber. I have specimens from Cumberland, Gloucestershire, Yorks, and Sussex. It is one of the prettiest and neatest worms indigenous to this country. Nearly related to this is another (*A. celtica*, Rosa), which, while it prefers trees, will thrive among decaying vegetable matter. I first found it at Langholm, N.B., some two years ago, but since then I have taken it plentifully in Carlisle, Morecambe, and Tunbridge Wells, besides receiving it from Sussex, Devonshire, Gloucestershire, Northants, and elsewhere. It bears spermatophores during the spring months.

When I was in the south of England in the early months of this year, I discovered a couple of specimens of a new British tree-worm (*A. constricta*, Rosa). This species seems to me to belong to the south, just as *D. Boeckii* belongs to the north. I am making notes on the distribution of these species in order if possible to ascertain their limits. A very anomalous worm (*Lumbricus Eiseni*, Levinsen) belongs to this group, though it has certain Lumbricus affinities. It is far from being a true Lumbricus, since it possesses neither *tubercula pubertatis* nor spermathecæ. Its girdle, too, is abnormal, for, whereas in the genuine Lumbricus the girdle invariably covers six segments, in this worm it extends over eight or nine. At present it does not fit in to any known genus, and should probably be made the type of a new genus. I have found it in Carlisle, Gloucestershire, and Sussex. Rosa has obtained it in Italy, and Levinsen in Copenhagen ; so that it appears to be very widely distributed. On the Continent one or two further species belonging to this group are on record. On account of their habits, size, and affinities I place them in the subgenus Dendrobæna, which may be presented in tabular form as follows :—

Tabular View of Subgenus Dendrobæna.

Dendrobæna	Segments occupied by the			Setæ.	Prostomium.	Colour.
	Girdle.	Tubercula.	First dorsal pore.			
Boeckii, Eisen ...	29—33	31 : 32 : 33	—	8 equidistant	Cuts $\frac{3}{4}$ peristomium	Dark brown
Subrubicunda, Eis.	26—31	28 : 29 : 30	$\frac{5}{6}$	4 wide pairs	Cuts one half	Rose red, fleshy
Arborea, Eisen ...	27—31	29 : 30	$\frac{5}{6}$	4 wide pairs	Cuts one half	Red brown, iridescent
Eiseni, Levinsen...	24—32	0	$\frac{5}{6}$	4 close pairs	Cuts the whole	Violaceous, iridescent
Constricta, Rosa...	26—31	0	$\frac{5}{6}$	4 pairs	Cuts one half	Rose red, fleshy
Celtica, Rosa ...	30—36	33 : 34	—	4 wide pairs	Cuts one half	Violaceous, ruddy

Another group of worms belonging to the genus Allolobophora, with features more or less similar to those of the typical earthworm, has recently been enlarged by the addition of two or three species. The first (*A. profuga*, Rosa) seems to be generally distributed throughout England, as I have received it from several localities. Its synonymy, however, is at present somewhat uncertain. The long worm (*A. longa*, Ude) is the most ubiquitous of all our native species, and has for years past been confused with the common earthworm. The other species must for the present be entered as *A. complanata* (Dugès). The Continental authorities differ in their judgment respecting the identity and synonymy of this worm, and I have hitherto been unable to disentangle the complications. Certain it is that we have a species which corresponds in part with the worm described imperfectly by Dugès, and I hope in a little time to be able to determine its exact relationships.

I append a list of all those species of British earthworms which I have personally collected, examined, and identified ; in each instance referring to the original memoir, and collating the worm with the author's description.

A List of Known British Earthworms.

	Author.	Date.	Memoir.
LUMBRICUS.			
1. Terrestris	Linnæus	1758	"Syst. Nat.," ed. x., tom. i., 647.
2 Rubellus	Hoffmeister	1845	"Familie der Regenwürmer."
3. Purpureus	Eisen	1870	*Öfversigt af K. Vet.-Akad.*
4. Rubescens	Friend	1891	Linnean Society, 1892.
ALLOLOBOPHORA.			
§ 1. Lumbricoidea.			
5. Longa	Ude	1886	*Zeitschrift f. Wiss. Zool.*
6. Profuga	Rosa	1884	"I Lumbricidi del Piemonte."
7. Complanata... ...	Dugès	1837	*Ann. des Sc. Nat.*, 2nd ser., viii.
§ 2. Mucida.			
8. Chlorotica	Savigny	1826	Cuv., "Hist. des. Prog. Sc. Nat.," ii.
9. Trapezoidea... ...	Dugès	1837	*Ann. des Sc. Nat.*, 2nd ser., viii.
10. Turgida	Eisen	1873	*Öfversigt af K. Vet.-Akad.*
11. Fœtida	Savigny	1828	Cuv., "Hist. Pr. Sc. Nat.," tom. iv.
12. Mucosa	Eisen	1873	*Öfversigt af K. Vet.-Akad.*
13. Cambrica	Friend	1892	NATURE, current issue.
§ 3. Dendrobæna.			
14. Boeckii	Eisen	1873	*Öfversigt af K. Vet.-Akad.*
15. Subrubicunda ...	Eisen	1873	,, ,, ,,
16. Arborea	Eisen	1873	,, ,, ,,
17. Eiseni	Levinsen	1883	"Syst. Geogr. Overs. over de Nord. An."
18. Constricta	Rosa	1884	"I Lumbricidi del Piemonte."
19. Celtica	Rosa	1886	*Bolletino dei Musei di Zoo. ed Anat.*
ALLURUS.			
20. Tetraedrus	Savigny	1828	Cuvier, "Hist. des. Prog.," tom. iv., p. 17.
21. Luteus	Eisen	1870	*Öfversigt af K. Vet.-Akad.*

When Darwin wrote his work on "Vegetable Mould," he assumed the existence of eight or ten species of earthworm in Great Britain. We now find a score of well-defined species, to which I have no doubt we shall be able to add a few others when the montane and out-of-the-way habitats have been explored. I shall be happy to receive consignments of living worms from any part of the kingdom, packed in tin boxes lightly filled with soft moss, and addressed The Grove, Idle, Bradford.

HILDERIC FRIEND.

THE PROBLEM OF MARINE BIOLOGY.[1]

IN common with the other branches of biological science, the study of marine life has made wonderful advances in the past half century, and we now begin to get a proper conception of the vastness and importance of this realm of nature.

The study of marine life has been compassed by serious difficulties; on shipboard it is impossible to examine in the living condition the enormous quantity and endless variety of forms brought up at a single haul of the net or dredge; and the old method of merely dropping the specimens into vials of alcohol resulted in vials of wrath to the naturalist who later studied the creatures in hopes of gaining from the distorted relics some knowledge of the normal appearance and anatomy. Now all this is changed, and by aid of certain chemical reagents most animals can be killed and preserved in a manner very satisfactory for study of their gross and microscopical anatomy, and hence the material collected can be examined at leisure in permanent laboratories with results corresponding to the better facilities. There has, too, been a great lack of suitable and accurate collecting apparatus. The early method was to scoop up a quantity of sea water and then tediously examine it in small quantities under the microscope. In 1845 Johannes Müller, the great pioneer of marine biology, conceived the idea of condensing into a small volume of water the forms which would be found in a very great area. This resulted in the invention of the "Müller Net," a small gauze net which is drawn through the water, entangling in its meshes the very minute and delicate organisms. For a long time Müller and his students pursued the study of marine forms, and at length came the discovery that the marine fauna and flora was directly comparable to the terrestrial.

Yet little is known of the laws of the distribution of marine life. The laws of the distribution of the terrestrial fauna and flora have been formulated for animals in the classical works of Wallace and for plants by Griesbach. The famous *Challenger* expedition (1873–1876), under the direction of Sir Wyville Thompson and Dr. John Murray, has given us the largest conception of the wealth of marine life, and has laid the foundations for the study of the marine forms both at the surface and in the depths of the ocean. Dr. Murray in his preliminary report called particular attention to the enormous wealth of organic life not only at the surface, but also many hundred fathoms below. He says that when living forms were scarce on the surface the tow net usually disclosed very numerous forms below, even to a depth of 1000 fathoms or more. In the North Pacific Ocean, the discovery was made that zones of definite depth are characterized by animals and plants peculiar to them. The tow nets sunk to 500, 1000, or 2000 fathoms brought up forms never found within 100 fathoms of the surface. The animals characteristic of these different depths are, for the most part, of the class of Radiolarians, those microscopic organisms whose silicous skeletons form much of the soft ooze which carpets the bottom of the deep sea. Prof. Haeckel, by study of this material, was led, in his monumental work on the Radiolaria, which forms a part of the "Report of the Challenger," to the recognition of three groups, (*a*) pelagic, swimming at the surface of the calm sea; (*b*) zonary, swimming in definite zones of depth (to a depth of more than 20,000 feet); (*c*) profound (or abyssal) animals swimming immediately over the bottom of the deep sea. In general the different characteristic forms correspond to the different zones (up to 27,000 feet).

The existence of this intermediate pelagic fauna was called in question by Alexander Agassiz, on the ground of the liability of error in using the ordinary open net instead of one which could be closed at a definite depth and then drawn up; and more particularly upon the ground of his own experiments made in 1878 on the *Blake* expedition. He believes that the great bulk of the ocean contains no organic life at all, that the surface fauna of the sea is limited to a relatively thin layer, and that there is no intermediate layer, so to speak, of animal life between the fauna of the bottom of the deep sea and of the surface.

Agassiz's results are contradicted by those of Chierchia on the Italian corvette *Vettor Pisani*. With the closable net invented by Palumko he brought up an astonishing quantity and variety of forms of life from different depths, even up to 4000 metres. Prof. Carl Chun, with an improved closable net, studied the marine fauna and flora of the Gulf of Naples. He formulates his results as follows: (1) That part of the Mediterranean investigated shows a rich pelagic life even to a depth of 1400 metres, as well as at the surface. (2) Pelagic animals, which during the winter and spring appear at the surface, at the beginning of summer seek the depths. (3) At greater depths pelagic animals occur, which hitherto have seldom or not at all been observed at the surface. (4) A number of pelagic animals during the summer remain at the surface and never go into the depths. From his observations upon the vertical distribution of marine life he was led to remark that the surface fauna was apparently only the advance guard of the vast army below. His conclusions were confirmed by observations made during a trip to the Canary Islands, and agree with those made by Prof. Haeckel twenty years before.

Prof. Hensen, of Kiel, has for several years past been studying the phenomena of pelagic life with a view of ascertaining its relations to the fisheries question. He has proposed the term Plankton (from πλάνομαι, to wander) to designate this world of marine life. Prof. Haeckel agrees with this and adds Planktology, that branch of biology which deals with the study of the Plankton. Prof. Hensen hopes to gain valuable information upon the phenomena of marine life by a careful mathematical estimation of the number of individuals in a given bulk of water. Presumably from this and other data some knowledge may be gained of the quantity of life which any definite area of the sea is capable of sustaining.

Prof. Ernst Haeckel, of Jena, has lately published an admirable *résumé* of our knowledge of pelagic life, and has made a very distinct advance by formulating some of the laws which govern its distribution. He has probably done more than any

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[1] Reprinted from the *American Naturalist* for October, 1892.